New Jersey Mercury Task Force

Volume III:
Sources of Mercury in New Jersey

Mercury-Containing Products: A Significant Source

January, 2002

Prepared for New Jersey Department of Environmental Protection

New Jersey Mercury Task Force Report
Volume III
Sources of Mercury in New Jersey

January, 2002

New Jersey Mercury Task Force

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Robert C. Shinn, Jr.
Commissioner

State of New Jersey

Christine Todd Whitman
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Department of Environmental Protection

Robert C. Shinn, Jr.
Commissioner

Department of Environmental Protection
Commissioner's Office
401 East State Street, 7th Floor
P.O. Box 402
Trenton, NJ 08625-0402

Dear Reader:

Mercury is a persistent, bioaccumulative, toxic pollutant. An organic form of mercury (methylmercury) has been found at unacceptably high levels in certain fish, and can cause serious health effects in some fish consumers. Other exposure routes are also potentially important, including exposure to primarily inorganic forms of mercury in some private well water.

Through a combination of source reduction and aggressive pollution control measures, we in New Jersey, have achieved some very notable reductions in the environmental releases of mercury over the past decade including reductions in emissions from municipal solid waste and medical waste incinerators.

More significant reductions are feasible and necessary. The Mercury Task Force recommends a strategic goal of an 85% decrease in in-state mercury emissions from 1990 to 2011. (This goal equates to a 65% decrease from today to 2011.) At my request, the Mercury Task Force has diligently assembled a vast body of information to serve as the basis for a comprehensive set of recommendations to reduce the environmental impacts of mercury releases. These recommendations are designed to provide New Jersey with its first comprehensive mercury pollution reduction plan. Implementation of these recommendations will limit mercury exposures to our citizens and our wildlife.

I would like to thank all of the Task Force members for their hard work and dedicated service to the citizens of New Jersey, and I am pleased to accept this comprehensive Mercury Task Force Report. I urge legislators, government officials, the environmental community, business and industry, the scientific and technical community, and all other interested citizens to review this report and determine how they can most effectively work in partnership with the New Jersey Department of Environmental Protection and other state agencies, to achieve these important New Jersey mercury reduction goals.

Sincerely,

Robert C. Shinn, Jr.
Commissioner

E O H S I

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November 2001

Commissioner Robert C. Shinn, Jr.
NJ Department of Environmental Protection
P.O. Box 402
Trenton, NJ 08625-04002

Dear Commissioner:

The members of the Task Force are pleased to submit to you our recommendations for reducing mercury impacts to the environment.

Mercury is a highly toxic material that has no known essential biological properties. It is toxic to adults, but the main health concern today is its potentially profound impact on the developing nervous system and the concern that fetal development can be significantly altered by even low levels of mercury (particularly methylmercury) in the mother's diet. This growing concern, spurred by recent epidemiologic research, has led many governments and other groups to address the problem of mercury in the environment.

Mercury's unique physical properties have led to its use for centuries in a wide variety of commercial applications and industrial processes. Its toxic properties have also been exploited in medicine, dentistry, agriculture, and paint manufacture. Although most uses have been eliminated or reduced (for example, mercury fungicides and batteries), or are being phased out today (for example, mercury thermometers), mercury remains in commerce in a number of forms including dental amalgams, fluorescent lights, thermostats, and certain electric switches.

Today, however, many of the most serious sources of mercury are inadvertent. These include the burning of waste, the use of coal to generate electricity, and the recycling of a variety of mercury-containing products, such as metals. Recognizing that toxic methylmercury occurred at surprisingly high levels in some freshwater fish from many waterbodies in the State, the New Jersey Department of Environmental Protection convened the first Mercury Task force in 1993. This advisory group concluded that emissions from municipal solid waste incinerators were, at that time, the main

controllable sources of mercury emissions in the state. Its recommendations and subsequent regulations led to a major reduction in mercury emissions from New Jersey incinerators; the targets set by the first Task Force for this particular industrial sector have been met and surpassed.

It has been my privilege to chair the second Mercury Task Force, convened in 1998 by Commissioner Robert C. Shinn, Jr., which has tackled a much wider array of mercury sources. Triggered, in part, by the concern that energy deregulation would increase the output from midwestern power plants which, as a whole, have relatively high emissions including mercury, the Task Force had to grapple at the outset with recommendations to assure that New Jersey's own energy deregulation law would not exacerbate New Jersey's mercury pollution problem. The Task Force went on to inventory many other sources of mercury to the environment, some of them unanticipated.

Our work has been rendered at times easier, and at times more difficult, by the many reports from federal agencies, other states, non-governmental organizations, and public interest groups that have appeared during the lifetime of the Task Force. New Jersey is by no means alone in considering various approaches, including legislation, to reduce mercury uses and emissions. It has indeed been an exciting time to learn about mercury.

For three years now I have had the opportunity to work with and learn from many dedicated and knowledgeable Task Force members and NJDEP representatives. We have also benefited from the numerous presentations made to the Task Force by outside groups, each with unique knowledge and perspectives. They are identified in Appendix VI.

Work on a voluntary Task Force of this nature is extremely demanding of time and energy. A number of Task Force members and other stable participants were indefatigable in their participation, and I particularly want to thank:

William Baker
Andrew Bellina
Janet Cox
Daniel Cunningham
Robert Dixon
Tom Fote
Betty Jensen
Russ Like
Jerry Marcus
Leslie McGeorge (NJDEP Representative)
Keith Michels
Robert Morris
Joel O'Connor
Valerie Thomas
Robert Tucker

Also, Dolores Phillips played a very active role in the origin and early deliberations of the Task Force.

Many NJDEP representatives contributed to the research and writing of the report. All are listed in Appendix IV.

I particularly thank Bob Morris, Alan Stern and Michael Aucott whose time commitments to the Task Force were great and who each co-chaired one of the two working sub-committees (Impacts and Sources). Leslie McGeorge coordinated all

NJDEP technical support for the Task Force, kept the Task Force focused on its charges and integrated its work with other NJDEP projects and programs. Sue Shannon coordinated various aspects of the Task Force and managed the communications and planning of meetings.

Other NJDEP staffers who made major contributions include:

Sunila Agrawal
Alan Bookman
Gary Buchanan
Robert Confer
Jim DeNoble
Mary Downes-Gastrich
Randy England
Joann Held
Mike McLinden
Eileen Murphy
Bill O'Sullivan
Anthony Pilawski
Bruce Ruppel
Michael Winka

I personally thank Commissioner Shinn for the thoughtful organization of the Task Force and his patience in awaiting this report. I trust that it will prove valuable in helping New Jersey and the Nation grapple with an insidious pollutant and reduce its impact on future generations. I echo his charge, that the lessons learned from mercury toxicity, mercury pollution and mercury control, should also help us in reducing human and ecosystem exposure to other environmental hazards which can threaten our growing population.

Sincerely yours,

Michael Gochfeld, MD, PhD
Chair

Charge to the Mercury Task Force
From Administrative Order 1998-08
Signed by Commissioner Shinn in March 1998

The mission of the Task Force is to develop a mercury pollution reduction plan for New Jersey. The Task Force is directed to complete the following tasks:

1. Review the current science on: a) impacts of mercury pollution on public health and ecosystems; and b) mercury deposition, transport, and exposure pathways.

2. Inventory and assess current sources of mercury pollution to the extent feasible, including both in-state and regional sources of mercury pollution.

3. Utilizing available information, quantify mercury pollution's impact on New Jersey's ecosystems, public health, and tourism and recreation industries.

4. Review New Jersey's existing mercury pollution policies.

5. Develop a mercury pollution reduction plan for the State of New Jersey, including:
   A) Recommend mercury emission controls and standards for in-state sources, including: coal fired generators; hazardous waste incinerators; sludge incinerators; hospital waste incinerators; and for other sources deemed necessary by the task force. In recommending controls and standards, the task force will explore renewable energy and alternative fuels to mercury emitting fuels now in use, and review innovative and low cost emission reduction strategies available in various industrial sectors.
   B) Provide timely interim recommendations, as feasible, prior to completion of the task force's overall mission, to the New Jersey Department of Environmental Protection, New Jersey Board of Public Utilities, other state agencies, interstate agencies, and the federal Environmental Protection Agency regarding mercury pollution, mercury pollution controls and standards and the relationship of energy deregulation to mercury pollution.

NJ Mercury Task Force
Final Report

Volume I
Executive Summary and Recommendations

Volume II
Exposure and Impacts

Volume III
Sources of Mercury to New Jersey's Environment

Volume III, Chapter 1: Overview of Sources of Mercury to New Jersey's Environment

A. Introduction

There are both natural and anthropogenic sources of mercury to the environment. The anthropogenic sources are many, and varied. This section describes the various anthropogenic sources in New Jersey that have been identified and estimated by the Task Force, and summarizes the inventory of anthropogenic sources. To provide a context for the various sources, a materials accounting of mercury in New Jersey is also presented. This accounting depicts estimated yearly flows of anthropogenic mercury in New Jersey, and also provides estimated reservoir quantities where possible. Also, to provide additional context, this section categorizes sources in the following three different ways:

1) Medium into which the source is released (air, water, soil, or disposal repository);
2) Reason for mercury's presence in the release; either intentionally added at some point in a product's life cycle, or present as a contaminant in a raw material; and
3) Sector from which the release occurs; residential, commercial, industrial, agricultural, government facility, utility or transportation.

Volume III, Chapter 3 presents details on each of a number of separate sources and source categories identified and researched by the Task Force.

B. Global, Regional, and Local Contributions to NJ's Environment

Mercury has long been used in commerce in a variety of products and applications, and it is an inherent contaminant of fossil fuels. There is ample evidence that global mercury deposition rates and background atmospheric concentrations have increased significantly over the past 150 years.[1,2] In one study, mercury accumulation rates in Great Lakes' sediments were found to have increased by factors ranging from 50 to over 200 from pre-industrial to modern times.[3] Even in relatively remote areas, mercury accumulation rates appear to be 3 or more times higher now than before the industrial age.[4,5] High levels of mercury in the environment are cause for concern primarily because a portion of that mercury is converted to methyl mercury, which accumulates in fish to levels that can harm humans and wildlife that consume the fish. Also, high mercury concentrations in air, usually due to spills in indoor environments, and mercury contamination of groundwater may be a concern.

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[1] Slemr, F., and E. Langer, 1992, Increase in global atmospheric concentrations of mercury inferred from measurements over the Atlantic Ocean, *Nature, 355*, 434-437.

[2] Fitzgerald, W. D. Engstrom, R. Mason, and E. Nater, 1997, The Case for atmospheric mercury contamination in remote areas, *Environ. Sci. Technol, 32, 1-7.*

[3] Pirrone, N., I. Allegrini, G. Keeler, J. Nriagu, R. Rossmann, and J. Robbins, 1998, Historical atmospheric mercury emissions and depositions in North America compared to mercury accumulations in sedimentary records, *Atmospheric Environment*, 32, 929-940.

[4] Lorey, P., and C. Driscoll, 1999, Historical trends of mercury deposition in Adirondack Lakes, *Environ. Sci. Technol*, *33*, 718-722.

[5] Swain, E. B., D. Engstrom, M. Brigham, T. Henning, and P. Brezonik, 1992, Increasing rates of atmospheric mercury deposition in mid-continental North America, *Science, 257*, 784-787.

Although there are natural emissions of mercury, it is believed that current global anthropogenic emissions are between 3600 and 4500 metric tons (8 to 10 million pounds) per year. The anthropogenic portion represents from 67% to greater than 75% of the yearly total global input.[6,7] The impact of anthropogenic emissions has led to a factor of three increase in the concentration of mercury in surface ocean waters over the last 150 years.[8] (The long times required for complete circulation of ocean water, on the order of 1000 years, mean that the deeper layers are still relatively uncontaminated by the recent human perturbations.) So-called natural emissions, many of which emanate from the surface of the oceans, are believed to include a sizeable component of recycled mercury that came originally from anthropogenic sources.[9] (See previous discussion of mercury in the environment and its transport and fate in Volume II, Chapter 1.)

The primary route of exposure in humans is consumption of fish contaminated with mercury. The principal mercury source to remote lakes is air deposition. Air deposition is also the main contributor to the oceanic burden of anthropogenic mercury, with rivers contributing only about 10% of the total mercury input to the world's oceans.[10] In New Jersey, while there are estimated to be relatively large discharges to some water bodies, the largest (in mass) mercury input to the environment is also believed to be air deposition. Air emissions are estimated to comprise the largest group of releases entering the ambient environment from which the mercury could eventually make its way to fish tissue. Uncertainties in these estimates remain. One uncertainty is the amount of mercury possibly recycled to a bioavailable form during dredging of mercury-containing sediments.

A materials accounting estimate for New Jersey has been developed. See Figure III.1.1, below. The figure depicts yearly flows in thousands of pounds where estimates are possible. Flow quantities, represented by arrows in the figure, represent one year's flow. In this figure, mercury inputs to the State in the form of raw materials and products, and outputs in many forms, including air emissions, direct releases to water and land, and transport to disposal facilities are shown.

Also shown in the figure are inputs to the state from wet and dry deposition from the atmosphere, which is the route by which it is believed most mercury that eventually becomes biologically available enters the environment. This quantity is a function of the quantity of mercury present in the atmosphere over New Jersey, and of the factors that lead to the conversion of this mercury into forms that are incorporated into precipitation or which are susceptible to dry deposition. This quantity is influenced by both in-state emissions and mercury transported into the state from elsewhere.

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[6] Mason, R. and W. Fitzgerald, 1996, The Global Mercury Cycle: Oceanic and Anthropogenic Aspects, in W. Baeyens et al. (eds*.), Global and Regional Mercury Cycles: Sources, Fluxes and Mass Balances*, 85-108. Kluwer Academic Publishers, Netherlands.

[7] Fitzgerald, W., personal communication, June, 2001.

[8] Mason, R, W. Fitzgerald, and F. Morel, 1994, Biogeochemical cycling of elemental mercury: anthropogenic influences, *Geochimica Cosmochimica Acta. 58*, 3191-3198.

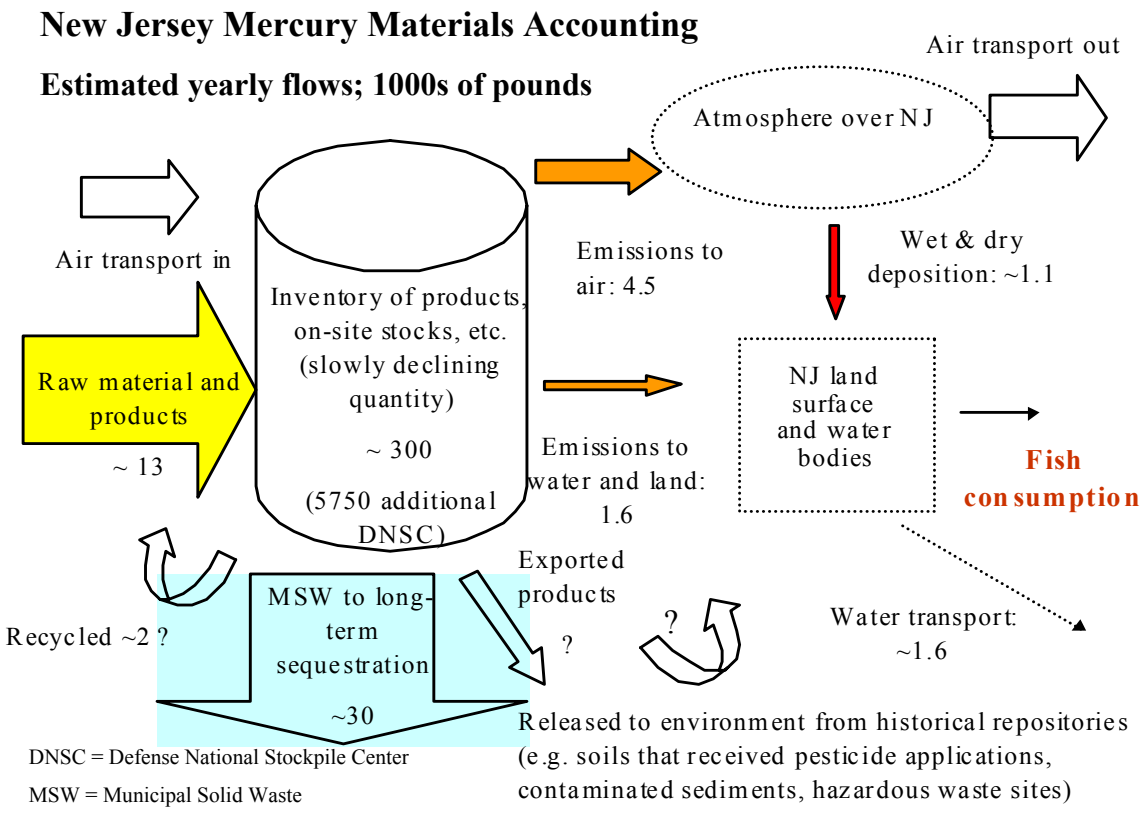
[9] Mason, Fitzgerald, Morel, 1994.

[10] Mason and Fitzgerald, 1996.

Also shown are vectors representing unknown or difficult to quantify fluxes of mercury. One such unknown flux is the release of mercury from historical repositories, which include the land surface and sediments. Another flux that is difficult to characterize in a materials accounting context is the mercury entrained in the atmosphere that flows across the state without depositing. This flux is likely to be large, but is not as relevant as the portion of that flux that becomes wet and dry deposition.

Also shown in the figure is the estimated inventory quantity. This includes mercury present in products and other items within the human environment, such as thermostats, thermometers, and dental amalgam. It is estimated that this inventory is slowly shrinking; the outflow, most of which is in the form of municipal solid waste (MSW) going to landfills, is larger than the inflow due to lower than previous use of mercury in products.

Figure III.1.1 1



The inventory of mercury contained in products and substances in use is augmented by 2615 metric tons of mercury stored at the Defense National Stockpile Center (DNSC) in Somerville, NJ, one of four national mercury storage sites. This mercury is stored in flasks in a secure, monitored warehouse. The U.S. defense national stockpile was established after World War II to ensure that the U.S. would have access to commodities needed for defense and other critical uses in times of national emergency. Today, due to

changing U.S. defense needs and access to global markets, the mercury in the stockpile has been declared excess. The DNSC is currently preparing a Mercury Management Environmental Impact Statement that will consider alternatives to continued storage at the sites. Alternatives to be considered include: 1) consolidating the mercury at one location for long-term storage; 2) stabilizing the mercury to reduce or eliminate toxicity and then storing or disposing of it; 3) selling it; or 4) leaving it where it is currently stored.

Deposition from the atmosphere is important in the overall cycle. One aspect of this deposition that remains problematic is the determination of its origin. A key difficulty in determining how much mercury deposition is contributed from in-state vs. out-of-state sources is that the mercury species of most emission sources are not well characterized. If an emission from any source is primarily elemental mercury vapor, it would be expected that only a very small percentage of this emission would be deposited in New Jersey. Most emissions of elemental mercury vapor would be expected to waft into the atmosphere and join the global atmospheric pool, which is believed to be primarily elemental mercury vapor. The half-life of atmospheric mercury is estimated to be about one year.[11] Therefore little elemental mercury will deposit near its point of origin. If, however, most of an emission is in the form of mercury bound to particles (e.g., soot) or mercury in the form of Hg^{++}, such as gaseous $HgCl_2$, it is expected that this mercury will deposit relatively near the source of the emission.

Existing data do not permit a definitive determination of how much of the mercury emissions from New Jersey sources is deposited locally. Some reports and models do provide some insight on the relative local and non-local share of deposition, however. It has been estimated, based on models, that perhaps one third of U.S. emissions to the air are deposited within the U.S., with the remainder joining the global atmospheric pool.[12] Other studies suggest that 50% of wet mercury deposition may be accounted for by local or regional sources.[13,14] One study[15] found in Florida (which because it is a peninsula, may not be typical of other regions) over 70% was from relatively local sources. A recent report indicates that deposition rates in relatively non-remote lakes in the upper mid-West have declined recently, but deposition in remote lakes has not declined.[16] This and another recent report[17] suggest that changes in mercury emissions from local sources can have a local impact. Preliminary analysis of data recently made available through the New Jersey Air Deposition Network (NJADN) project[18] also suggest that air deposition

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[11] Slemr, and Langer, 1992.

[12] USEPA, 1997, *Mercury Study Report to Congress, Volume 1*, EPA-452/R-97-003, p. O-1.

[13] Electric Power Research Institute, 1994, Expert Panel on Mercury Atmospheric Processes. *Mercury Atmospheric Processes: A Synthesis Report*; EPRI/TR-104214; Workshop Proceedings, 1994.

[14] Bullock, O. R., K. A. Brehme, and G. R. Mapp, 1998, *Sci. Total Environ*., 213,1.

[15] Dvonch, J., J. Graney, G. Keeler, and R. Stevens, 1999, Use of elemental tracers to source apportion mercury in South Florida precipitation, *Environ. Sci. Technol, 33*, 4522-4527.

[16] Engstrom, Daniel, and Edward Swain, 1997, Recent declines in atmospheric mercury deposition in the upper midwest, *Environ. Sci. Technol, 31*, 960-967.

[17] Lindberg, S., and W. Stratton, 1998, *Environ. Sci. Technol 32,* 49-57.

[18] Reinfelder, John, 2000, Report on mercury deposition data from New Jersey Air Deposition Network, 2000, Rutgers University, presented at *Scientific Perspectives on Mercury Management in the Hudson-Delaware Region, Fall Hudson-Delaware SETAC Workshop*, Monmouth University, West Long Branch, NJ, September 29, 2000.

in remote New Jersey regions may be lower than that in urban areas. If most airborne mercury comes from distant sources, more uniform fallout patterns would be expected, and so local and regional sources may be important contributors to deposition quantities. Further, it is currently assumed that between 20 and 80 percent of mercury emissions are elemental (Hg^{o}) and that the remainder is either gaseous oxidized (Hg^{++}) or on particles.[19] It is expected that the non-elemental forms will deposit relatively locally, especially during rain events.

Based on the reports cited above, it is likely that approximately half of the mercury that is deposited in New Jersey comes from relatively nearby sources. A definitive apportionment of deposition from local, regional, and global sources must await the acquisition of better data on the species of mercury emissions.

A comparison of emissions from in-state sources with deposition estimates based on the data from the NJADN and the national Mercury Deposition Network[20] reveals that New Jersey emissions of mercury are greater than what is deposited from the atmosphere. The state is, from a global perspective, a net exporter of atmospheric mercury. With the intensity of industrial activity, population, and associated uses of mercury-containing products and fuels, a net export of mercury from the state, and from most industrial regions of the world, would be expected.

With its variety of significant mercury uses and mercury sources, New Jersey is in a position to take a leadership role in reducing the releases of mercury to the environment. Because these sources are numerous and varied, an overall understanding of the flows of mercury in industry and commerce is useful. In the discussion that follows, these flows will be explored in more detail and then the various sources will be described and viewed from several perspectives.

Recent research suggests that reductions of anthropogenic emissions of mercury will lead to relatively rapid reductions in concentrations in aquatic species. A Florida modeling study indicated that control of mercury emissions could significantly alleviate the overall Everglades mercury problem within a decade or two.[21] Other research suggests that, in the New York/New Jersey Harbor, the half-life of mercury may be in the range of 20 years.[22] (A half-life of 20 years suggests that, if fresh inputs of mercury are reduced to zero, concentrations of mercury in aquatic species will decline by 50% during the following 20 years.)

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[19] NESCAUM, NEWMOA, NEIWPC and EMAN, 1998, *Northeast States and Eastern Canadian Provinces Mercury Study: A Framework for Action.* Northeast States for Coordinated Air Use Management, Boston, MA.

[20] The Mercury Deposition Network is part of the National Atmospheric Deposition Program, http://nadp.sws.uiuc.edu/mdn/. Data from a number of sites reported for the years 1996 through 1999 show wet deposition rates for the Northeastern U.S. in the range of 10 : $g/m^2/yr$.

[21] South Florida Water Management District (SFWMA) and Florida Department of Environmental (FLDEP) Protection, 2001, 2001 Everglades Consolidated Report, SFWMA, 3301 Gun Club Road, West Palm Beach, FL, 33406; FLDEP, 2600 Blair Stone Road, Tallahassee, FL 32399.

[22] Mason, Rob, personal communication, August 23, 2001.

C. New Jersey Source Inventory

C.1. Releases to air, water, and land

The Task Force estimates that, based on data from the late 1990s and 2000, releases to the air, water, and land are as depicted in Figures III.1.2 and III.1.3. In these figures, estimated uncertainties are shown with the bars extending to the left and to the right of the source bar, representing the range of values in which the real value could reasonably be expected. These uncertainties are judgements reflecting the Task Force's confidence in the numbers. The confidence level of the source quantity is based primarily on the origin of the data, and on the degree of variability in the data that exists. Some of the estimates are based on stack tests performed under the supervision of the New Jersey DEP. Other estimates are based on mass balances which in turn are based on testing results from laboratories that are DEP-approved, or otherwise believed to be reliable, or have been reported in peer-reviewed literature. Still other estimates are derived with other approaches, including engineering judgement based on available information.

Table III.1.1, below, shows the approximate source quantities, medium to which the release occurs, source of the data, and degree of certainty. Degree of certainty in this table is defined as certain (C), moderately certain (MC), or uncertain (U). In this context, certain means the estimated quantity is believed accurate to within ± 50%; moderately certain means believed accurate to within ± 75%, and uncertain means the estimate could easily be inaccurate by more than 75%.

There are source categories that are not shown in Table III.1.1. These include categories for which no estimates are available, such as possible releases of mercury application of sludge-derived products and fertilizers, possible releases of mercury from non-incineration treatment of medical waste, and possible releases of mercury during dredging and subsequent stabilization and deposition of dredged materials. Changes in the Toxic Release Inventory reporting threshold for mercury (from 10,000 lbs./yr. down to 10 lbs./yr.), effective calendar year 2000, are to be reported in July 2001. This information should also provide information regarding industrial releases which may be small individually, but whose cumulative releases could be significant.

Figure III.1.2. 1

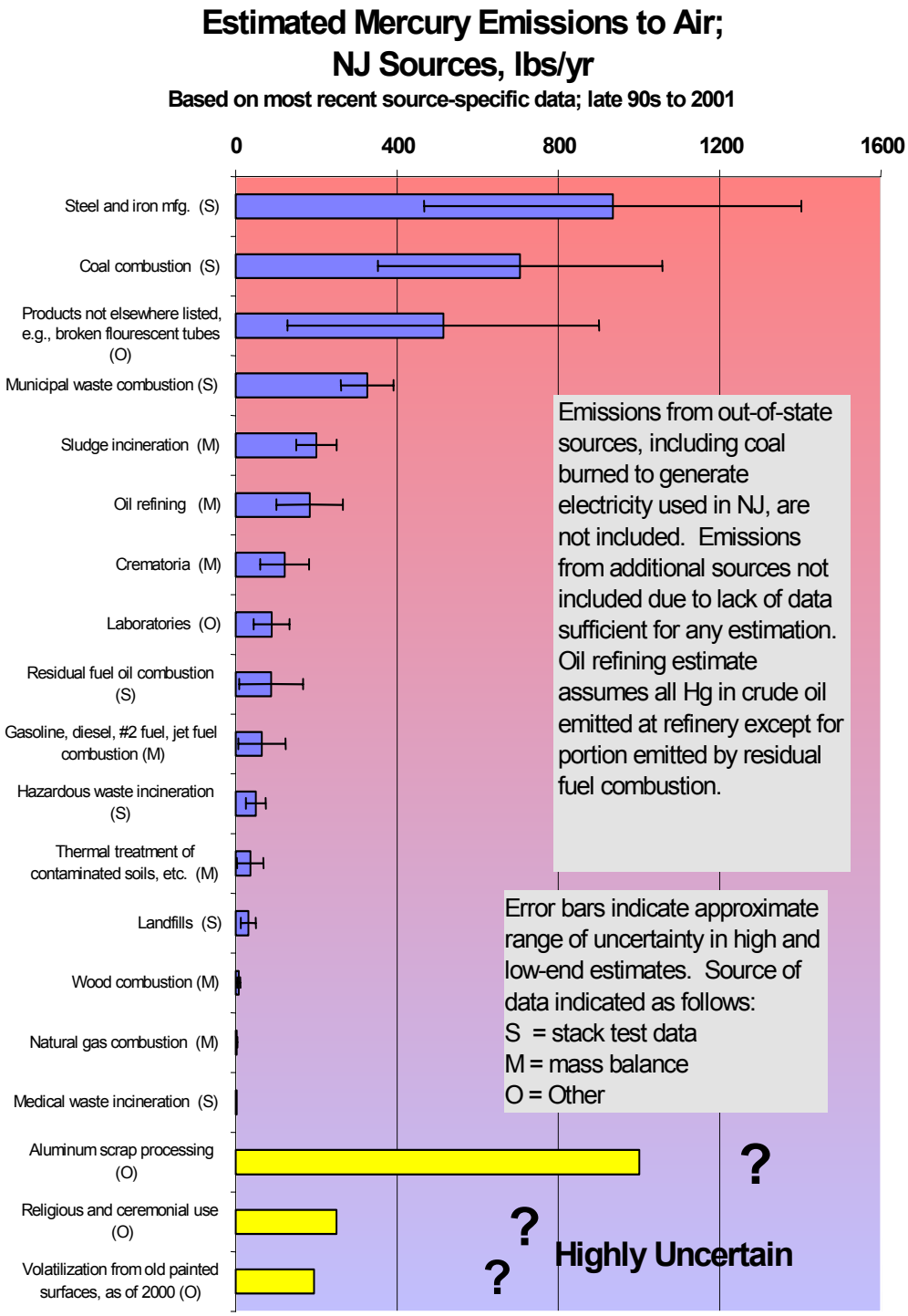
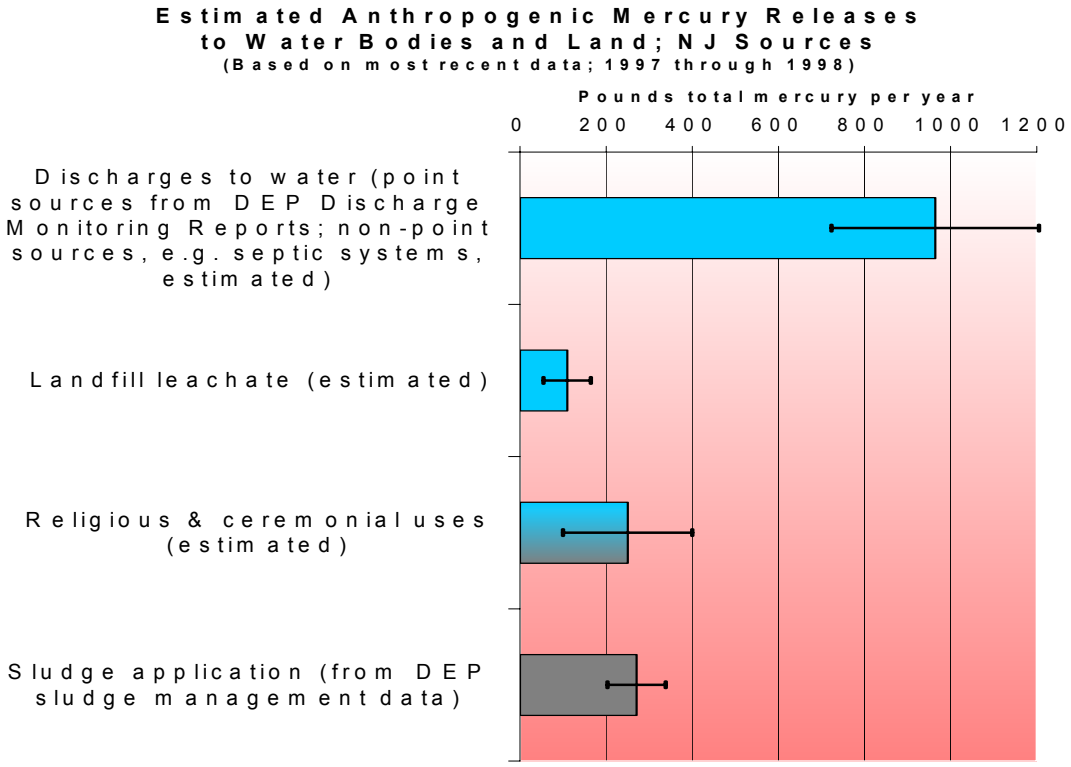


Figure III.1.3. 1



Not shown in Table III.1.1 are the species of the mercury emission. This is a poorly understood variable that is important, regarding the distance from a source wherein an air emission can be expected to deposit, and the biological availability of the source. A source relatively small in quantity could still have a large impact on human health or the environment, depending on the species of that source.

Also not shown in Table III.1.1, is the large amount, estimated to be in the range of 300,000 pounds, of mercury present in buildings, equipment, and products in use in New Jersey. Estimated emissions from this reservoir are included under the "volatilization, miscellaneous" category.

An important source category of a different nature is deposition from the air, both dry and wet. Air deposition is the way that most mercury reaches the environment of New Jersey. Current estimates, based on the NJADN project,[23] place the air deposition quantity in the range of 900 to 1200 pounds per year. Further data to be gathered through the NJADN project and other sources will refine this estimate. As discussed above, some, perhaps 50%, of this deposition can be attributed to nearby sources. More research is needed to clarify the relative contribution of in-state and out-of-state sources to the air deposition quantity.

Table III.1.1

[23] Reinfelder, John, 2000.

Anthropogenic Mercury Releases and Transfers in NJ (For details, see Chapter 3)

Source category	Approx. release (lbs./yr.)	Medium to which release occurs	Source of data (S= stack tests, M = mass balance, O = other)	Degree of certainty (C = certain, MC = moderately certain, UC = uncertain)
Released to water and land				
Surface & ground water[1]	1000	water	M	MC
Landfill leachate	100	water	O	UC
Cultural uses	*250*	water/land	O	*Very uncertain*
Sludge application	250	land	M	MC
Total	**1600**			**MC**
Released to air				
Steel & iron mfg.	1000	air	S	MC
Aluminum scrap processing	*1000*	air	O	*Very uncertain*
Coal combustion	700	air	S	MC
MSW incineration	330	air	S	C
Volatilization (miscellaneous)[2]	300	air	O	UC
Cultural uses	*250*	air	O	*Very uncertain*
Fluorescent tube breakage[3]	240	air	O	UC
Sludge incineration	200	air	M	C
Oil refining	200	air[4]	M	MC
Old painted surfaces[5]	*200*	air	O	*Very uncertain*
Crematoria	100	air	M	MC
Residual fuel combustion	100	air	S	UC
Volatilization (laboratory)	100	air	O	UC
Gasoline, diesel, etc.[6]	50	air	M	UC
Hazardous waste incineration	50	air	S	UC
Thermal treatment[7]	50	air	O	UC
Landfills	40	air	S	C
Wood combustion	10	air	O	MC
Natural gas combustion	5	air	M	MC
Medical waste incineration	5	air	S	MC
Total	**4930**			**MC**
Transferred to NJ disposal sites[8]				
Dredged materials	17,000	na	M	UC
Solid waste (not including out-of-state)	13,600	na	M	MC
Total	**30,600**			**UC**

Notes:
[1] Based on NJDEP discharge monitoring reports covering permitted discharges of mercury and mercury compounds to surface and ground water, and augmented by estimated discharges from private septic systems.
[2] Includes estimated volatilization from other mercury-containing discarded items and items in service.
[3] Estimated volatilization from discarded fluorescent tubes during waste handling and processing but before ultimate disposal.
[4] Quantity is relatively certain, based on sampling and analysis of crude oil. Media to which releases may occur are uncertain; assumed to be primarily air, but could include wastewater or other waste streams.
[5] Emissions from this source category are believed to have been sizeable from the 1960s until the early 1990s, when mercury fungicides were removed from paint. It is estimated that emissions have been rapidly declining since the early 1990s. Estimated 2000 emission is approximately 200 pounds/year; it is expected the quantity will approach zero by 2005.
[6] Also includes #2 fuel oil, kerosene, and jet fuel.
[7] Represents emissions from processing of contaminated soils, etc.
[8] Eventual release rate to the ambient environment is unknown.

C.2. Releases based on sector where release originates

Another way to categorize release sources is by the sector from which the release originates. This approach offers insight in developing reduction strategies, particularly those that involve outreach and communication. Source sectors can be considered to be residential (private dwellings), commercial (including retail stores, hospitals, schools and other institutions), industrial (manufacturing facilities), electric power generation, transportation, government (municipal solid waste management and public wastewater management), and agriculture. An apportionment of New Jersey mercury releases by sector is presented in Figure III.1.4. The largest sector is industrial, primarily because of the emissions from iron and steel manufacturing and the inclusion of the potentially large, although not well-characterized, emissions from aluminum manufacturing. Other large sectors include electric power generation (coal combustion), residential (due to apportionment of wastewater and to religious and ceremonial use estimates), and government (which includes municipal solid waste incineration and wastewater treatment plants).

There is not a database that apportions different sources to different sectors. Releases from products during use and waste management were assigned 25% each to industrial, commercial, residential and government. Releases from municipal waste combustion, landfills, and sludge incineration were assigned to government. Volatilization from old painted surfaces was assigned 33% each to industry, commercial, and residential. Releases from coal and residual fuel combustion was assigned to the electric power generation sector. Releases from cultural and ceremonial uses were assigned to the residential sector. Discharges to water were assigned 25% each to the industrial and commercial sectors, and 50% to the residential sector. Releases from sludge application were assigned to agriculture. Releases from laboratories were assigned 50% each to industry and the commercial sector. Releases from gasoline, diesel fuel, kerosene, and jet fuel were assigned to the transportation sector. Other releases were assigned to the industrial sector. All percentages should be assumed to be uncertain.

C.3. Releases based on origin of mercury

Instead of organizing mercury releases based on the medium to which the release occurs (air, water, or land), releases can be organized by the origin of the mercury. There are two broad categories of origin. In one case, mercury can be intentionally added to a product or used directly in an intentional manner. This mercury will then be released, or transferred to a disposal site such as a landfill at some point in the product's life cycle or during the use of the mercury. An example is the mercury used in a measuring device, such as a thermometer. Alternatively, mercury can be present as an unwanted contaminant in a product. Release may occur during use, or through breakage or disposal. An example is the release of mercury during coal combustion.[24] Another example is mercury present at low levels in potable water. When this water becomes

[24] Note that the percentage from incidental contaminants in this chart does not include mercury released from coal combusted out-of-state to supply electricity used in New Jersey. See section on coal combustion in Volume III, Chapter 3.

wastewater, the mercury is still present and may become incorporated in wastewater treatment plant sludge, or be included in mercury in a wastewater discharge.

A review of the mercury releases catalogued above suggests that approximately 80% of the mercury released from New Jersey sources is mercury intentionally added to products. See Figure III.1.5. The many points at which mercury can be released to the environment from a product are illustrated in Figure III.1.6, which depicts the mass flow of mercury through the disposal system.

Figure III.1.4 1

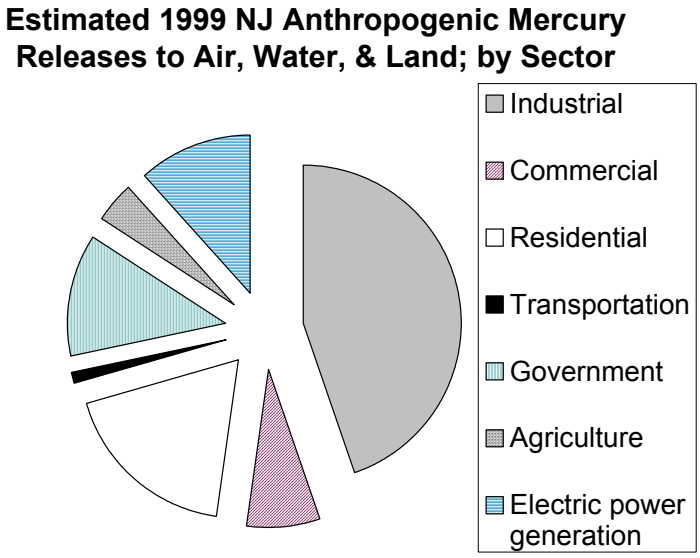


Figure III.1.5. 1

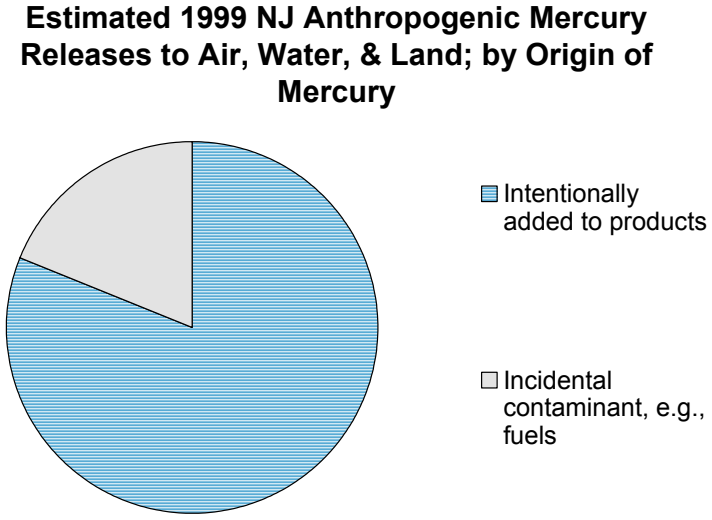
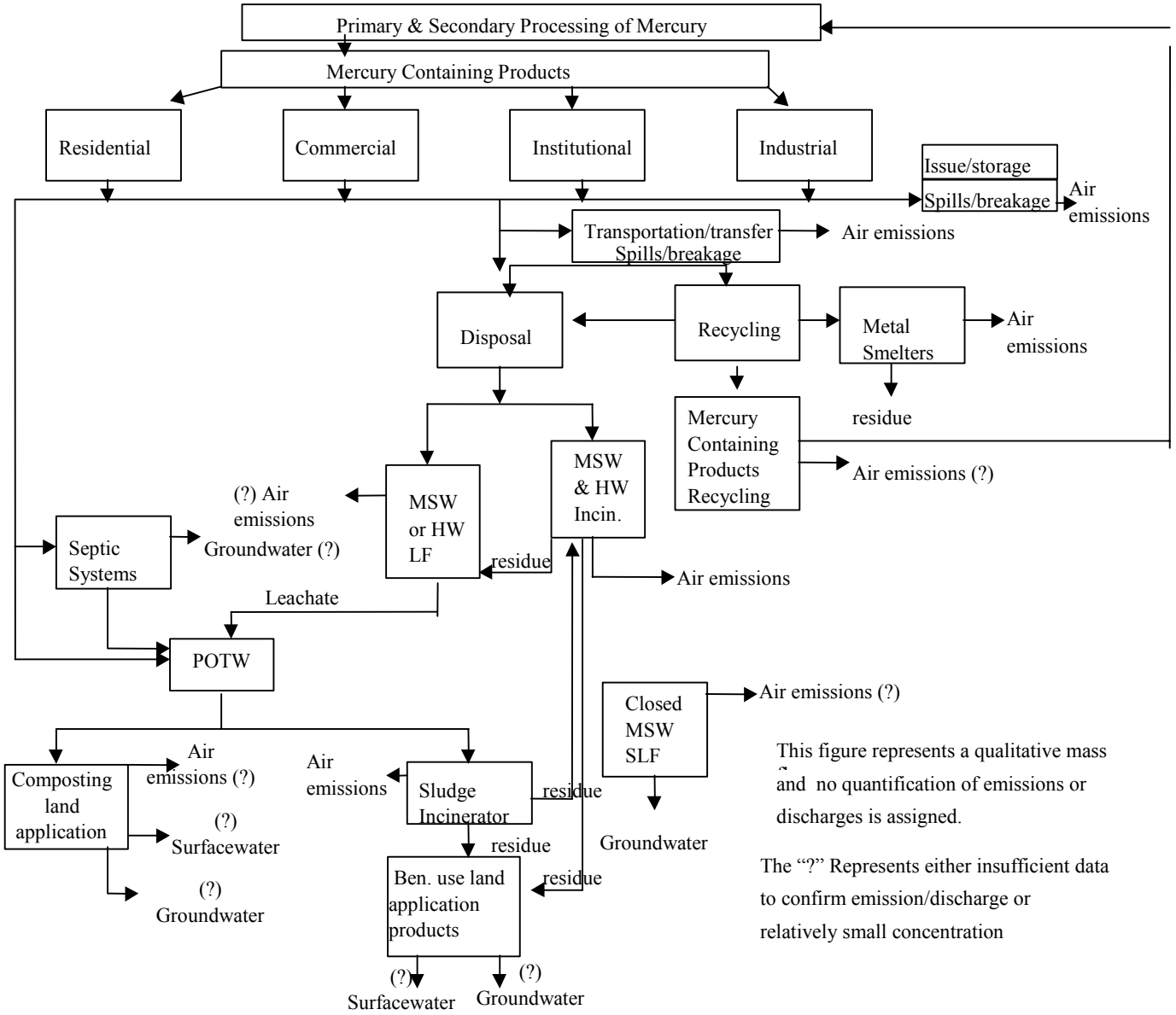


Figure III.1.6. 1

Mass Flow of Mercury Through the Disposal System



POTW = Publicly owned treatment works (sewage treatment plant)
MSW = Municipal solid waste
HW = Hazardous waste
Ben. use = Beneficial use
LF or SLF = Landfill (or sanitary landfill)